Global Mortality from Outdoor Smoke, with Fay Johnston and Sarah Henderson

Ashley Ahearn

Burning forests, grasslands, and fields have been part of the landscape probably for as long as humans have been on the planet. But it's only in recent years that we've begun to explore the health effects of exposure to landscape fire smoke, which is now known to exacerbate preexisting disease and induce new disease. In some parts of the world, people are chronically exposed to smoke from landscape fires that burn for a large portion of the year. In other areas, exposure is sporadic and short-term. In this podcast, host Ashley Ahearn talks to Fay Johnston and Sarah Henderson about their study in which they estimate the number of deaths worldwide attributable to smoke from landscape fires.

AHEARN: It's *The Researcher's Perspective*. I'm Ashley Ahearn.

Fire has shaped the land and ecosystems of the planet for millions of years. And people have been exposed to smoke from burning trees and grass probably for as long as we've been on the planet. But it's only in the last decade or so that we've begun to explore the health effects of being exposed to that smoke.

Recently *EHP* published a paper titled "Estimated Mortality Attributable to Smoke from Landscape Fires."[i]

Joining me now are two of the authors of the paper. Dr. Fay Johnston is a physician and environmental epidemiologist at the Menzies Research Institute in Tasmania. Hi, Fay.

JOHNSTON: Hello, Ashley.

And Dr. Sarah Henderson is an environmental epidemiologist at the British Columbia Center for Disease Control. Hi, Sarah.

HENDERSON: Hi, Ashley.

AHEARN: So, let's start big picture here, Fay. Every year there are fires all over the world. How did your team quantify the exposure, globally, of people to this specific kind of air pollution?

JOHNSTON: Well, our team included people who are experts in the field of global fire modeling, and what they did was, they got data from satellites that go around the Earth twice a day and are able to give information about fire activity. So we were getting a vision of Earth from space, and that information was broken down into grid cells across the Earth, and we were able to work out where the fires were burning, how much smoke and other sort of pollution was emitted from those fires, and then by using atmospheric models, [we were] able to work out where that smoke was going, how long it lasted in the atmosphere, and that gave us a good idea every single day, for every single grid cell, how much smoke came from landscape fires. And we were able then to combine that with information about how many people live in each grid cell and what their underlying health and population death rates are, and, putting all that together, were able to come up with some estimates for the mortality that we can attribute to the smoke from fires.

AHEARN: So Sarah, from that exposure how did you quantify mortality? How do these

fires actually kill people?

HENDERSON: Well, that's a challenging question. We assumed that fires can kill people in two sorts of different ways. There's those areas that aren't affected by fire very often, and there might be a fire once or twice a year, and there's a lot of smoke injected into the area for a few short days, and those really acute changes in the air pollution can affect people with preexisting diseases. So those are the sporadically affected areas of the globe.

And then in the other areas of the globe, fires actually burn for large portions of the year almost every year, and exposure to smoke more chronically from fires like that actually induces the development of respiratory and cardiovascular diseases in people. And we treated those areas as chronically exposed and assumed that the mortality in those areas was due to the development of those kinds of diseases.

I should clarify that we didn't actually look at mortality due to specific causes in this study; we looked at mortality due to all causes, and that's really because there's not a lot of evidence in this area, and most of the evidence that we have for the health effects of forest fire smoke on mortality is around mortality from all causes.

AHEARN: How many people did you estimate die every year from exposure to smoke from fire events, both the chronic and the short term?

JOHNSTON: Our principal analysis, as Sarah explained earlier, was an estimate that

treated places sporadically exposed one way and places chronically exposed another way, and when we put those together we got an overall estimate of around 340,000 deaths per year, and that varied according to the region and the level of fire activity in those regions.

AHEARN: Fay, where did you see the highest estimated mortality from smoke?

JOHNSTON: The highest estimated mortality we found in sub-Saharan Africa. That's a region where there's huge exposure from smoke, both from clearing rainforests and from savannahs that burn for several months each year. It's also an area, as you know, where the underlying mortality rates are very high, and putting those two factors together gave us a very high estimate of around 160,000 deaths per year. The second highest area was Southeast Asia, and again, that's a very densely populated area that gets enormous exposure, and the exposure in Southeast Asia largely comes from using fire to clear tropical rainforests for other purposes—for planting palm trees for palm oil and such like.

AHEARN: So what might be in that smoke, and how does smoke from a wildfire, for example, compare with air pollution in downtown Beijing on a bad day?

HENDERSON: Forest fire smoke is a really complicated mixture of stuff. There's lots of gases, carbon monoxide, there's stuff like formaldehyde. There's heavy metals, like lead and mercury, and then, you know, the way that public health people normally measure forest fire smoke is the size of the particulate matter, so it's solid mass that comes as part of the smoke—how little those particles are. And in terms of how forest fire smoke compares with

something like urban pollution in a really densely populated, dirty city, actual particles are about the same size, but the composition of the particles is quite different,[ii] and there's still some uncertainty about whether it's the size of the particles or the composition of the particles or the two put together that elicits the health effects.

JOHNSTON: Just to add to that, when people have done health studies, there's been a huge amount of health studies done on urban air pollution and far fewer, of course, done on landscape fire smoke. But overall, when it comes to the mortality rates associated with different types of air pollution, the studies we have so far tend to indicate that it's probably similar or within the similar range.

AHEARN: Fay, how do you hope your research is used, and where are the areas of greatest concern that your findings could be applied to?

JOHNSTON: There's many areas that have direct relevance for this research. Landscape fire smoke is a really clear example of how we manage the land and what humans do to their environment and how that directly translates into health effects on populations. For example, we know that fire is a natural part of the Earth system. Many vegetation types require fire, and they need to burn anyway. We know it's a completely impossible idea to banish fire from our landscapes, but then how do we learn to live with it? In Australia there's lots of emphasis now on prescribed burning to reduce fuels to decrease the risk of severe fires, and we know that smoke is harmful, but there really is an evidence gap about the relative harm. Severe fires we know have a lot of smoke and are associated with increases in mortalities. A

whole series of smaller fires also produce smoke that are also going to have health effects, and the evidence about what's the safe level of exposure and what's an acceptable, a socially acceptable tradeoff between how much you can do deliberate burning in order to avoid huge catastrophes less frequently is an area that really needs a lot more work.

The other really important message, I think, from our work is the issue with burning rainforests to clear land for other purposes. Rainforests are one of the areas on Earth that doesn't normally support fire under natural circumstances—they're too wet to burn—and yet the burning and clearing of rainforests is responsible for a really high proportion of fires and fire smoke and contributes to a lot of deaths from smoke in both sub-Saharan Africa and especially in Southeast Asia, where it's actually the major source of landscape fire smoke. And that's one area where lives could be saved immediately if this practice were to be changed, and in theory it's one that can be changed—[rainforest] doesn't naturally burn anyway. In practice, of course, it's a lot more complicated.

AHEARN: Fay, Sarah, thanks so much for joining me.

JOHNSTON: Thank you.

HENDERSON: Thank you very much for having us, Ashley.

AHEARN: Dr. Fay Johnston is a physician and environmental epidemiologist at the Menzies Research Institute in Tasmania. And Dr. Sarah Henderson is an environmental

epidemiologist at the British Columbia Center for Disease Control.

And that's *The Researcher's Perspective*. I'm Ashley Ahearn. Thanks for downloading!

Ashley Ahearn, host of *The Researcher's Perspective*, has been a producer and reporter for National Public Radio and an Annenberg Fellow at the University of Southern California specializing in science journalism.

References and Notes

[i] Johnston FH, Henderson SB, Chen Y, et al. Estimated global mortality attributable to smoke from landscape fires. Environ Health Perspect; http://dx.doi.org/10.1289/ehp.1104422 [online 18 Feb 2012].

[ii] Wegesser TC, Pinkerton KE, Last JA. California wildfires of 2008: coarse and fine particulate matter toxicity. Environ Health Perspect 117(6):893–897 (2009); http://dx.doi.org/10.1289/ehp.0800166.